Jurnal Inovasi Teknologi Pendidikan
Volume 11, No. 4, December 2024 (377-380)
Online: http://journal.uny.ac.id/index.php/jitp

Digital skills assessment in blended learning settings in mathematics and physics education programs

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ARTICLE INFO

Article History
Received:
25 January 2024;
Revised:
21 November 2024;
Accepted:
28 November 2024;
Available online:
31 December 2024.

Keywords
Digital skills; Self-assessment; Core digital skills; Contextual digital skills; Blended learning

ABSTRACT

Digitally savvy human resources are becoming more necessary. Through a survey, this research assesses students' digital skills after implementing blended learning. A total of 143 mathematics and physics teacher students provided their self-assessments of 25 indicators of digital skills. The findings show that around 50% of students can adapt to technology, and 61% rate it well for their creative ability in dealing with ideas. However, there is potential for improvement in problem-solving skills. In cultural awareness, more than 90% of students demonstrated respect for other cultures, although around 23% rated it sufficient for cultural understanding. Student ethics in using technology were high, with more than 85% stating they had good abilities. Assessments of core and contextual digital skills show a tendency for students to give higher ratings to core skills, but assessment variations are pretty significant. The mean scores and standard deviations for both skill categories indicate a level of variation that is noteworthy. This study provides in-depth insight into students' digital skills assessment, identifies potential areas for further development, and highlights the need for increased cultural awareness among students. This research recommends further investigation to determine the types of digital skills students gain from the wider use of the Internet and how well these skills fit the needs of the digital age.

How to cite:
Maulidiya, D., Putri, D.H. & Lestary, R. (2024). Digital skills assessment in blended learning settings in mathematics and physics education programs. *Jurnal Inovasi Teknologi Pendidikan, 11*(4), 377-380. https://doi.org/10.21831/jitp.v11i4.70998

INTRODUCTION

The development of information technology in Indonesia, as reflected by the National Statistics Agency's (BPS) survey between 2019 and 2022, shows significant trends in Internet use among students at various levels of education. The survey results highlighted quite a marked increase, with the percentage of students using the Internet increasing from around 53% to more than 76%. This increase is in line with the surge in student cell phone use. The National Statistics Agency's survey findings create a picture of a significant transformation in students' behavior as digital learners, who are increasingly allocating more time to use technology flexibly (Tiba & Condy, 2021). This phenomenon highlights the need for a deep understanding of the characteristics of digital learners. Digital learners are individuals who actively use technology to obtain, process, and interact with information in various learning contexts (Tiba & Condy, 2021). This generation can adapt quickly to new technologies (Alibrahim, 2024). The dominance of digital technology in Industry 4.0 necessitates enhanced technological proficiency, particularly for future generations, emphasizing the

importance of educational reforms that not only transfer knowledge but also focus on imparting the skills required to meet the challenges of this era (Ekantiningsih & Sukirman, 2023).

Along with this change, the need for human resources who have digital skills is increasing. Laar et al., (2017) defined digital skills as the capacity for lifelong learning, supporting higher-level thinking, and mastering technology to accomplish tasks. Digital skills are applying specific knowledge and talents that can be applied and measured in digital use (Iordache et al., 2017). The educational context also reflects the importance of digital skills for facing challenges in this digital era. Laar et al., (2017) emphasize that developing digital skills is integral to the teaching and learning process. It aims to ensure that students not only master these skills in the classroom environment but can also apply them in life and work in the ever-growing digital era. During the pandemic COVID-19, teachers enhanced their technology and teaching skills, demonstrating their students' high digital skills and ability to learn independently, demonstrating their quick adaptability to new technologies (Alibrahim, 2024). Thus, teachers are expected to be able to use technology to create learning to facilitate the characteristics of digital learners by training their digital skills.

The educational context also reflects the importance of digital skills as provisions for facing challenges in this digital era. Teachers, serving as facilitators in education, should ensure students' learning convenience through the effective use of innovative learning media, particularly ICT, to stimulate optimal student potential (Ekantiningsih & Sukirman, 2023). The UNESCO-UNEVOC study highlights the need for differentiated support for teachers to effectively use digital tools and services, including building digital skills, knowledge of new technologies, and developing competencies in new pedagogical approaches (Subrahmanyam, 2022). Laar et al., (2017) emphasize that developing digital skills is integral to the teaching and learning process. It aims to ensure that students not only master these skills in the classroom environment but can also apply them in life and work in the ever-growing digital era. Thus, teachers are expected to be able to use technology to create learning to facilitate the characteristics of digital learners and train students' digital skills.

Several empirical studies have described the ability of prospective teachers or teachers in Indonesia to use technology. For example, survey results of 208 prospective teachers in Jakarta found that although the perception of self-confidence in using technology was positive, integrating technology, pedagogy, and teaching materials still needed improvement (Diamah et al., 2023). A study in 2022 on 901 Indonesian teachers found that effective learning can be achieved through technology if teachers have high confidence in using it in classrooms (Prasetiyo et al., 2022). Diamah et al., (2023) suggest that prospective teachers still need to improve their digital skills in lectures. For example, by applying project-based learning methods to train collaboration or research-based learning to increase creativity (Lavi et al., 2021). Therefore, prospective teachers must be equipped with knowledge and trained in skills using digital technology for learning.

The first step before designing a skills improvement program for prospective teachers is identifying their initial skills. Many studies have reviewed hundreds or thousands of scientific articles discussing digital skills and formulated relevant dimensions, factors, and indicators. The digital skills framework proposed groups digital skills based on core and contextual (Laar et al., 2017). Core digital skills include technical, information management, communication, collaboration, creativity, critical thinking, and problem-solving. Contextual digital skills include ethical awareness, cultural awareness, flexibility, self-direction, and lifelong learning. This research aims to analyze the digital skills of prospective mathematics and physics teachers based on core and contextual skills. Core skills provide a foundation for performing specific tasks, while contextual skills provide adaptability and flexibility to apply those core skills in different contexts (Laar et al., 2017).

Regarding technological experiences, Tiba & Condy (2021) reported that teachers' TPACK (Technology Pedagogy and Content Knowledge) assessments improved when they were modeled to integrate technology, pedagogy, and material knowledge throughout their prospective teacher education. TPACK covers aspects of digital skills in the context of teaching and learning, while digital skills are more general and involve the ability to use technology in various life contexts. TPACK can be considered as part of digital skills that are more specific to the world of education. Teacher education institutions should integrate digital skills with practical applications and review assessment design to deepen preservice Teachers' TPACK development (Bothe, 2023). Demographic, socioeconomic, age, gender, education level, personality, psychology, and prior

technological experience all substantially impact technical aspects, information management, problem-solving, and communication (Laar et al., 2020). It shows, that more research is required to determine how core and contextual skills relate.

On the other hand, the basic skills needed for digital skills include using the Internet and online content, for example, through e-learning (Laar et al., 2020). Tiba & Condy (2021) stated that knowledgeable and skilled teachers will use technology effectively to constructively change the teaching and learning process so that students also get used to using technology for good purposes. Teachers at all levels need to be taught digital literacy skills using a variety of approaches to deal with the realities of technology in the classroom (Zayas & Rofi'ah, 2022). Therefore, prospective teachers must have the skills to select, design, create, modify, and use Internet-based technology and digital content for classroom learning. In other words, getting used to digital technology needs to be planned systematically in learning.

Laar et al., (2020) stated that prospective teachers' readiness to use technology during teaching is influenced by three factors: projects and workshops on technology, resources, and modeling the use of technology by lecturers and supervising teachers in schools. Digital skills are improved through technology in learning, where students develop thinking skills, creativity, practice, and participate in project assignments (Pipatjumroenkul et al., 2019). Integrating digital literacy skills into learning can improve students' functional skills, creativity, collaboration, communication, critical thinking, cultural and social understanding, and cyber security awareness (Webb & Layton, 2023). Introducing digital tools and technology-assisted pedagogical strategies integrated into teacher or prospective teacher education programs is one of the keys to success in increasing digital skills (Zayas & Rofi'ah, 2022).

Combining online and offline learning, namely blended learning, can expand communication channels between students and between teachers and students, learning flexibility, personalization, the development of independent learning, and cost efficiency (Müller & Mildenberger, 2021; Smith & Hill, 2019). The development of blended learning aims to combine the best characteristics of face-to-face and online learning to increase active participation and learning independence (Khoiroh et al., 2017). Teachers integrate online learning as part of blended learning and use technology for a variety of educational purposes, such as providing additional lessons, completing homework, and communicating with students and parents (Alibrahim, 2024). Depending on each institution's capacity, choosing a blended learning model that suits its demands based on facilities, the financial situation, the subject and curriculum, and more is imperative (Tong et al., 2022).

The blended pedagogy approach improved digital competencies among the teacher trainees, particularly in areas such as internet navigation, mobile Internet operation, internet-based search engines, and formal internet skills (Buluma & Walimbwa, 2021). Implementing blended learning provides students with the experience of opening and downloading modules or learning materials whenever needed (Kusyanti, 2022). Blended learning gives students the readiness for in-person interactions and allows teachers to assess learning outcomes and decide on the best course of action for future learning activities more rapidly (Yuricha & Phan, 2023). Thus, the blended learning approach makes a positive contribution to improving communication, learning flexibility, and student independence while strengthening teachers' digital competence. In addition to improving knowledge, abilities, and attitudes, blended learning also has the positive impact of reducing the expense of courses and training (Abuejheisheh et al., 2023).

The advantages of blended learning are relevant to the digital skills that prospective teachers are expected to have in the era of digital technology. The knowledge, skills, and competencies required for teaching in technology-enhanced environments differ from those for face-to-face teaching, especially when asynchronous delivery is used (Alibrahim, 2024). However, there is a gap in understanding the specific digital skills and competencies students develop or lack during this increased Internet use, especially in blended learning settings, and how these align with the digital skills required in teaching. Meanwhile, the value of including digital literacy skills in teacher preparation is acknowledged, but little is known about how well various methods work to foster these abilities. It is necessary to research to identify the digital skills enhanced by blended learning and their alignment with the expectations of the digital era in education for preservice teachers. This

study addresses the digital skills assessment method for student teachers through blended learning, offering recommendations for improvement based on assessment results. It contributes to the development of effective teacher training curricula and learning strategies for preparing teachers for the digital demands of modern education.

METHOD

Research Design

This study is descriptive quantitative research using a survey method that aims to analyze the digital skills of prospective mathematics and physics teacher students in blended learning. The blended learning environment provides conditions for exploring sufficient essential experience and skills for using technology in learning. Face-to-face learning is carried out in the lecture hall, while online learning is carried out via http://elearning.unib.ac.id, which was developed using Moodle as a Web-based Learning Management System (LMS). Moodle allows the construction of online teaching environments with teaching materials and the creation of activities, such as quizzes, interactions during continuous lectures, and tests for assessment (Ifinedo et al., 2018). This research uses a descriptive quantitative approach because it allows systematic data collection through survey instruments, and then analyzed quantitatively to an explanation of students' digital skills (Bhat et al., 2024).

Sampling Technique

The sampling technique used was purposive sampling, with the criteria of prospective mathematics and physics teacher students who had completed blended learning-based lectures. This technique was chosen because the respondents were seen as having characteristics that were relevant to the research objectives, namely to evaluate their digital skills in the context of technology-based learning (Bhat et al., 2024). Data in survey research is obtained from several individuals by asking questions and then using their answers to provide certain information (Lukitasari et al., 2022). The research respondents were 143 prospective mathematics and physics teacher students at a state university in Sumatera, aged 17–21 years. The proportion of respondents based on gender was 81.1% women and 18.9% men.

Data Collection

Data were collected using an online questionnaire distributed via Google Forms. The questionnaire instrument was adapted from the (Laar et al., 2017) framework, which includes 25 digital skill indicators divided into all seven core skills and three contextual skills (ethical awareness, cultural awareness, and flexibility). Self-direction and lifelong learning were not measured in this study because they require measurement more than one time through observation and interviews, which involve qualitative aspects that are difficult to convert into quantitative data that can be measured. The assessment was carried out using a three-point Likert scale: Good (3), Fair (2), and Poor (1). Before participating in the study, all respondents were provided with detailed information about the research objectives, procedures, and their rights as participants. An informed consent form outlining their voluntary participation was presented, and their responses would remain anonymous and confidential. Only those who fully understood and willingly agreed to the terms of participation were allowed to proceed with the self-assessment questionnaire. Table 1 consists of the dimensions and indicators of digital skills used in the research.

Table 1. Dimension and Indicators of Digital Skills

No.	Categories	Dimensions	Indicators
1.	Core Digital Skills (Y)	Technical (TC)	TC1. Able to use Mobile Devices and Applications to Complete Practical Tasks. TC2. Able to use the Features in E-learning to Complete Assignments.

No.	Categories	Dimensions	Indicators
		Information management (IM)	IM1: Able to use technology to efficiently search for information when making the most suitable decisions for specific tasks.
			IM2: Able to use technology to select information efficiently when making decisions for specific tasks.
			IM3: Able to use Technology to Organize Information Efficiently when Making the most Suitable Decisions for Specific Tasks.
		Communication (CM)	CM1. Able to use Technology to Send Information to Others.
			CM2. Able to use Technology to Ensure that the Meaning of Information is Expressed Effectively.
		Collaboration (CL)	CL1. Able to use Technology to Develop Social Networks in Teams to Exchange Information.
			CL2. Able to use Technology to Work in Teams to Exchange Information.
			CL3. Able to use Technology to Negotiate Deals with Mutual Respect for a Common Goal.
			CL4. Able to use Technology to Make Decisions with Mutual Respect to a Common Goal.
		Creativity (CR)	CR1. Able To Use Technology To Generate New Ideas Into Something New.
			CR2. Able to use Technology to Treat Current Ideas in a New Way Into Something New.
		Critical Thinking (CT)	CT1. Able to use Technology to Make Decisions based on Acquired Information.
			CT2. Able to use Technology to Make Choices based on Acquired Information.
			CT3. Able to use Technology to Communicate Logically to Support a Statement.
		Problem Solving (PS)	PS1. Able to use Technology to Cognitively Understand Problem Situations to Find Solutions.
2.	Contextual Digital Skills (X)	Ethical Awareness (EA)	EA1. Able to Behave Socially Responsibly when using Technology.
			EA2. Able to Demonstrate Awareness when using Technology.
			EA3. Able to Behave Ethically by Applicable Laws when using Technology.
		Cultural Awareness (CA)	CA1. Able to Demonstrate Cultural Understanding when using Technology.
			CA2. Able to Respect Other Cultures when using Technology.
		Flexibility (FL)	FL1. Able to Adjust One's Thinking to Change the Technological Environment.
			FL2. Able to Adjust One's Attitude to Change the Technological Environment.
			FL3. Able to Adjust One's Behavior to Change the Technological Environment.

(Laar et al., 2017)

Data Analysis

The data collected were analyzed using descriptive statistics to assess students' digital skills in both core and contextual skill dimensions. The results of the data processing are presented through charts and tables, which illustrate the distribution of digital skills across each indicator and allow for a comparison of students' skills in core and contextual skills.

RESULTS AND DISCUSSION

Results

Data is collected at the end of lectures that apply blended learning. Students are asked to assess their digital skills based on good, fair, or poor criteria for 25 indicators. This research compares the value of individual digital skills between core and contextual skills. All indicator values for each skill category are given a value in the range 1–3. To determine performance levels, the average scores for each dimension were categorized as good (2.35–3.00), fair (1.68–2.34), and poor (1.00–1.67). The individual assessment results are visualized in the following scatter plot in Figure 1.

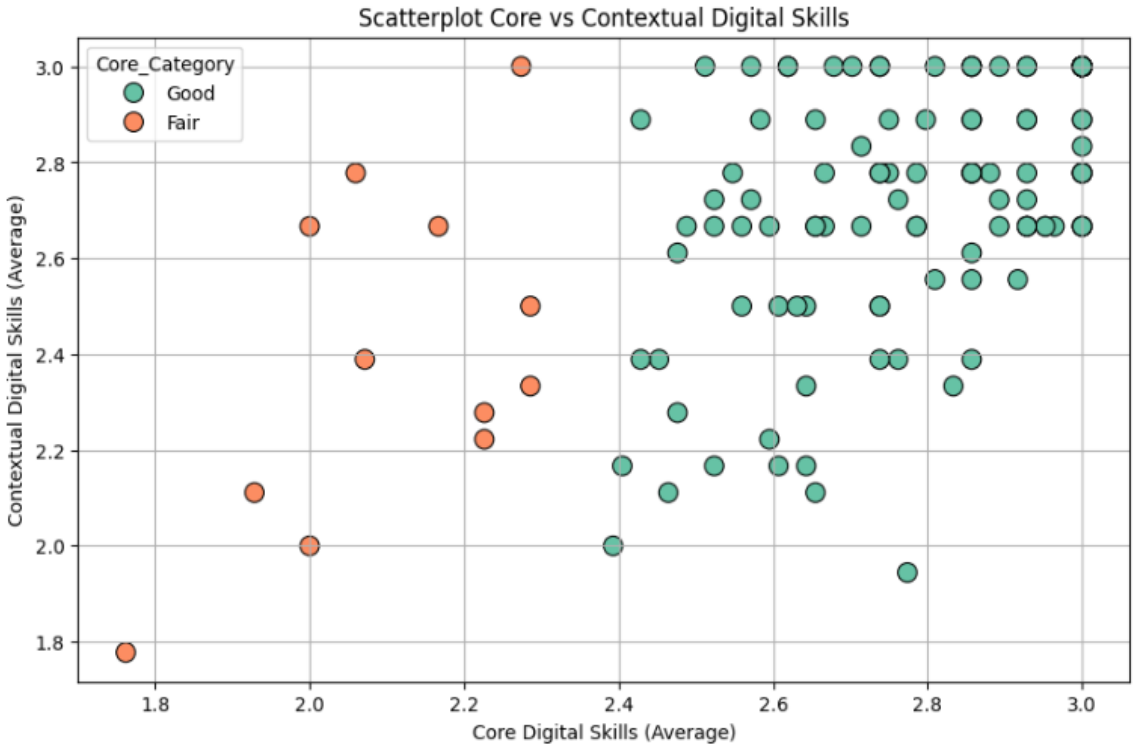

Figure 1. Scatter Plot of Individual Assessments Between Core and Contextual Digital Skills

The scatterplot analysis in Figure 1 illustrates the relationship between core and contextual digital skills among participants. Each data point represents an individual, with their average core digital skills score plotted on the x-axis and their average contextual digital skills score on the y-axis. The color-coded data points, distinguishing individuals categorized as "good" or "fair," reveal no significant differences in the relationship between the two skill sets across these categories.

Most data points are concentrated in the upper-right quadrant, indicating that a majority of individuals demonstrate strong performance in both skill categories. Out of 143 prospective teachers, 12 individuals were categorized as having fair core digital skills, and among them, only 5 had fair contextual digital skills. The remaining 91.61% (131 out of 143) of participants demonstrated good core digital skills, although 10 individuals in this group were categorized as having fair contextual digital skills. These results indicate a higher proportion of participants achieving good performance in core skills compared to contextual skills. However, notable variations exist, as some individuals with high core digital skills scores exhibit relatively lower contextual skills scores, and vice versa. This highlights diversity in skill profiles across the sample.

These findings suggest that core and contextual digital skills are interrelated, and strengthening one dimension may support improvements in the other. This insight underlines the importance of integrating both skill sets in digital skill enhancement programs to ensure comprehensive digital literacy development. Figure 2 below shows the percentage of each dimension.

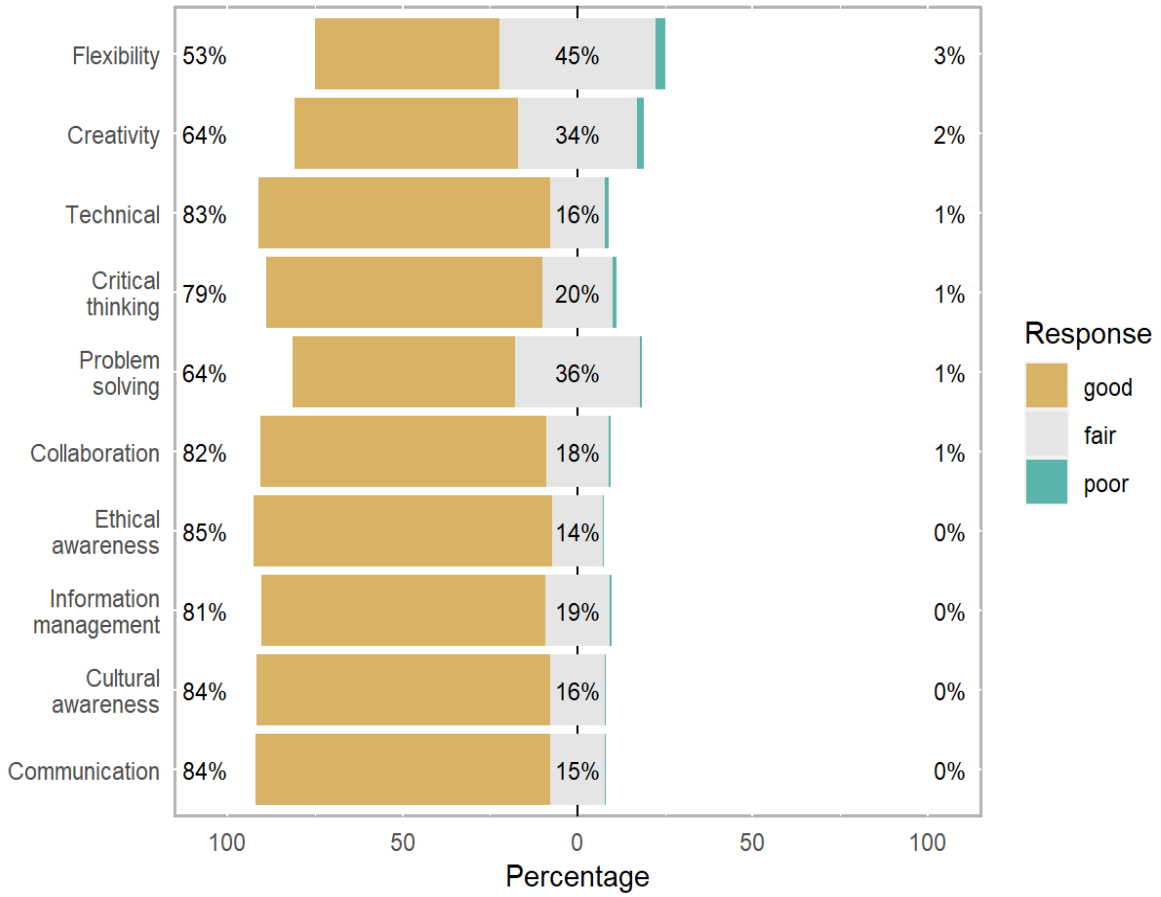

Figure 2. Average Percentage of Digital Skills Dimension Assessments

The response results show that most students believe they have a good core (around 78%) and contextual (around 73%) digital skills. An interesting finding from this research is the cultural awareness dimension. More than 90% of students stated that they can respect other cultures when using technology. However, there are still around 23% who consider it sufficient to demonstrate cultural understanding when using technology. Therefore, there is potential to increase further cultural awareness of the use of technology among students, although most of them already have a strong foundation in this dimension.

On the other hand, in the ethical awareness dimension, more than 85% of students stated they had good abilities. Students can behave socially responsibly, demonstrate awareness, and be ethical by the law when using technology. This positive value shows that they have a strong moral foundation and commitment to using technology. It provides a solid basis for forming professionalism and integrity in the context of future use of technology.

Meanwhile, for technical, collaborative, ethical, information management, cultural, and communication abilities, more than 81% of students received good ratings. However, if we look in detail at the dimensions of creativity, problem-solving, and flexibility, less than 70% of students have good skills. Around 34 – 45% of students rated themselves in the adequate category in these three dimensions. Thus, efforts are still needed to increase skills in creativity, problem-solving, and flexibility among students.

This study also identifies in greater depth the specific digital skill indicators that require more attention. By analyzing the distribution of scores across the Good, Fair, and Poor categories for each indicator, it becomes evident where there are opportunities for improvement. Figure 3 illustrates this comparison, providing a detailed percentage breakdown for each indicator.

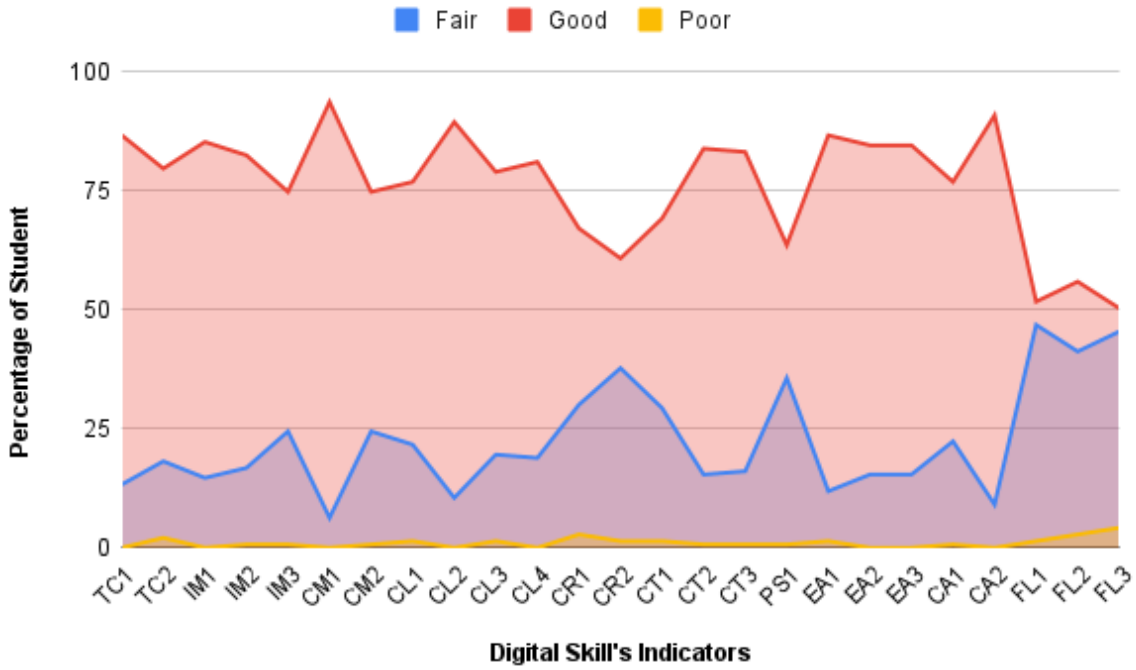

Figure 3. Distribution of Student Ratings for Each Digital Skill Indicator

As shown in Figure 3, certain indicators in both Core Digital Skills and Contextual Digital Skills have potential for improvement. For instance, in the Technical (TC) dimension, TC1 (the ability to use mobile devices and applications to complete practical tasks) stands out with a high proportion of participants (86.71%) falling in the good category. However, TC2 (the ability to use e-learning features effectively to complete assignments) shows a slightly lower performance, with 79.72% in the good category and a noticeable percentage (18.18%) in the Fair category. This discrepancy suggests that while most participants are adept at using mobile devices and applications, there is a gap in the mastery of e-learning platforms that should be addressed to improve the overall learning experience. Technical digital skills, which include handling software, social media channels, and the internet for task completion, as well as basic digital problem-solving, are essential for everyday tasks across professions and can significantly enhance productivity in educational settings (Bouwmans et al., 2024).

In the Information Management (IM) dimension, indicators such as IM1 (the ability to use technology to efficiently search for information) and IM2 (the ability to select information efficiently) show strong performance, with over 85% of participants scoring in the good category. However, IM3 (the ability to organize information efficiently) exhibits a more diverse distribution, with a larger proportion of participants (24.48%) categorized as Fair. This highlights a potential area for growth, suggesting that while participants are capable of searching and selecting information, organizing it effectively remains a challenge.

In the Creativity (CR) dimension, the indicator CR1 (using technology to generate new ideas) receives a favorable score, with 81.12% in the good category. However, CR2 (using technology to treat existing ideas in a new way) presents a notable gap, as 30.07% of participants are rated in the Fair category. This indicates that while participants are generally good at generating new ideas, their ability to apply creative processes to existing ideas and produce innovative results is an area that needs more attention.

Within the Problem Solving (PS) dimension, PS1 (using technology to understand problem situations and find solutions) reflects a mixed performance. While 63.64% of participants are rated as Good, a significant proportion (35.66%) fall into the Fair category. This suggests that although many participants possess a foundational understanding of problem-solving with technology, further support and skill development are necessary to enhance their ability to apply technology effectively in more complex problem-solving contexts.

In the Contextual Digital Skills, the Flexibility (FL) dimension shows mixed results. While FL1 (adjusting thinking to changes in the technological environment) is strong, with 90.91% in the good category, the indicators FL2 (adjusting attitudes) and FL3 (adjusting behavior) show a more concerning trend, with 22.38% of participants in the Fair category for both indicators. This suggests that while students are capable of adjusting their thought processes to new technological environments, they struggle with adapting their attitudes and behaviors to these changes, which could hinder their full integration and effectiveness in dynamic technological settings.

Overall, this analysis reveals that while participants generally perform well in most dimensions, several areas—particularly in Problem Solving, Creativity, and Flexibility—require additional focus and development. These findings suggest the need for targeted interventions to enhance specific digital competencies, ensuring that participants are not only proficient in using technology but also able to apply it in innovative, adaptable, and effective ways.

Discussion

This study highlights various aspects relevant to students' digital skills in a blended learning context. The previous research reveals that in a blended learning context, core skills (e.g., basic digital literacy) and contextual skills (e.g., application in specific learning environments) are interdependent, influencing overall digital competency (Satar et al., 2024). The study reveals that core digital skills, such as technical, information management, communication, and critical thinking, are rated higher than contextual skills like ethical awareness and cultural awareness. Interestingly, only 5 out of 12 students with fair core skills demonstrated fair contextual digital skills, suggesting that students with fair core skills often face challenges in contextual skills. These variations in assessment indicate differences in perception among students, highlighting the complexity of assessing digital skills in a blended learning context.

This research found that students rated it as fair for problem-solving skills but rated it as good for critical thinking. It reflects students' ability to use technology for logical decision-making and effective communication. Critical thinking involves analyzing information, evaluating arguments, and making reasoned decisions. It is essential for effective communication and is increasingly integrated into educational frameworks to prepare students for the workforce (Thornhill-Miller et al., 2023). In contrast, problem-solving requires deeper cognitive engagement, such as understanding complex situations and formulating appropriate solutions. These findings are consistent with prior research indicating that critical thinking involves more technical applications of technology, while problem-solving requires deeper cognitive engagement (Laar et al., 2017; Saekawati & Nasrudin, 2021). While critical thinking and problem-solving are often viewed as separate skills, they are interrelated. In the research's context, blended learning allows students to deepen their critical thinking and problem-solving skills through combining e-learning and face-to-face courses. It is often linked to higher-order thinking skills, which can be fostered through active learning strategies such as problem-based learning and collaboration-driven approaches (Patiño et al., 2023).

The student assessment for critical thinking aligns with the assessment for the collaboration dimension, which is considered good. It is related to student activities in collaborative group work, providing opportunities to collaborate in planning, implementing, negotiating, and evaluating when solving problems (Saekawati & Nasrudin, 2021). Problem-solving skills are considered essential abilities that involve analyzing complex situations, identifying challenges, and developing practical solutions. Blended learning facilitates students receiving material explanations from teachers and using e-learning, which can be accessed anywhere and at any time (Sari et al., 2022). When it comes to problem-solving, students must have access to various information, including material that can be quickly found online. However, it is also essential to consider the suitability of the data selection for the discussed topic (Shalihah et al., 2019).

Problem-solving skills are essential for resolving problems, making informed decisions, and adapting to changing circumstances. As done by Sari et al., (2022), five crucial elements of blended learning, namely live events, online content, collaboration, evaluation, and reference materials, are used to combine the concepts of blended learning and project-based learning with building knowledge and skills in problem-solving. In this context, Bothe (2023) emphasizes integrating digital

skills development in teacher education to equip pre-service teachers with the knowledge and skills acquired during school placements, enabling them to effectively solve problems and adapt to technology-rich educational environments. This integration guarantees that pre-service instructors are more prepared to solve difficulties and adjust to technologically advanced educational contexts.

On the other hand, discussion forums in e-learning allow students to collaborate and share information and understanding to solve the problems they are facing. Social interaction in e-learning expands discussion opportunities that have been carried out in the classroom (Saekawati & Nasrudin, 2021). Data from student responses in e-learning reflects their ability to use technology to understand problem situations and find solutions cognitively. This analysis shows that although students assess problem-solving skills as sufficient, some components have been facilitated in blended learning. Thus, it is necessary to design learning activities in blended learning to explore more challenging cognitive understanding of situations.

Digital flexibility skills refer to the ability to adapt and adjust to changes in the digital context, especially in the era of continuously developing information and communication technology. Theoretically, blended learning allows students to learn at their own pace and access course materials online, resulting in a more flexible and personalized learning experience. Blended learning allows students to manage learning independently through materials, discussion forums, and feedback freely available in e-learning (Khoiroh et al., 2017). However, this research shows that, in general, students as prospective teachers still need to train their flexibility to move between platforms, adapt to new technology, and overcome challenges that arise with changes in the digital environment.

The study's results by Laar et al., (2020) show that problem-solving and creativity skills are significantly determined by experience and flexibility in using technology. Further improvement of flexibility skills in using technology for problem-solving and creativity can be done through blended learning. Blended learning requires students to be active, learn to focus, and explore information from various sources, especially the Internet (Shalihah et al., 2019). The previous study demonstrates that a blended learning support system, including learning planning, content, activities, and assessments, can significantly enhance the digital literacy of prospective teachers, proving to be a practical and effective solution (Rahmi et al., 2024). This research shows a blended learning approach in developing the digital flexibility skills of student teachers, enabling them to be better prepared to face changes and demands in an ever-evolving digital environment.

One of the e-learning features that can be utilized in blended learning is data log activities. Log data analysis can reveal students' engagement patterns, indicating their consistency and discipline in accessing and submitting online assignments (Zare et al., 2023). Log data analysis on Moodle can reveal active student times, engagement patterns, and peak activity periods through the examination of event logs (Rotelli & Monreale, 2023). If the activity log shows a high participation level, this indicates active engagement in learning. Group discussion strategies, collaborative projects, problem-solving activities, and interactive online modules carried out in e-learning to complement face-to-face learning effectively improve digital skills and competencies (Buluma & Walimbwa, 2021). The analysis of log activities is relevant to important aspects of blended learning. Kusyanti (2022) mentions the critical aspects of blended learning, including a combination of technology, pedagogy, and chronology (synchronous/asynchronous).

Log data has a chronology feature that shows the time and frequency of e-learning access by students. Log data analysis can reveal patterns in student activity frequency, such as peak times for reading materials, participating in forums, or completing quizzes (Darmawan, 2024). This information helps lecturers understand students' preferred time patterns in accessing material or interacting with assignments. If online assignments or exams exist, log data can show how often students access and submit assignments. It can be an indicator of consistency and level of discipline. Additionally, by analyzing log data, institutions can design personalized learning pathways, ensuring students receive support tailored to their individual engagement and performance trends (Kim & Park, 2022).

Apart from that, from a pedagogical aspect, through log data, lecturers can see the materials or modules that are most frequently accessed by students, making it helpful in assessing the level of interest or difficulty in specific courses. In this research, e-learning is also equipped with online quizzes, announcements, and links. Access log data to these features is used to understand how

students utilize various learning features (Darmawan, 2024). Increasing student participation in e-learning increases digital skills (Pipatjumroenkul et al., 2019). Blended learning enhances students' and teachers' technology skills, teaching strategies, and personal development by integrating interactive applications and enhancing digital skills, while also promoting independent learning (Alibrahim, 2024). This research shows that the application of blended learning in lectures has a generally positive impact on assessing students' digital skills, both core and contextual skills, as prospective teachers.

CONCLUSION

The research findings highlight the need for increased focus on specific aspects of learning to improve digital skills. Research shows differences in students' assessments of core and contextual digital skills. Creativity is recognized as a core skill in the digital era. However, assessments show that students feel less able to be creative. Even though problem-solving is considered adequate, critical thinking and collaboration skills are excellent. On the other hand, although theoretically, blended learning facilitates flexibility in learning, this research shows that students need to exercise their flexibility in switching between platforms and adapting to new technology. Most students rated higher for core skills, while variations in ratings reflected differences in perceptions among students. It emphasizes the complexity of assessing digital skills in a blended learning context.

Implementing blended learning generally positively impacts assessing students' digital skills. Technology integration, online quizzes, announcements, and other features in e-learning help increase participation and digital skills. E-learning activity log data helps understand students' participation, preference time patterns, interests or difficulties, and level of discipline. Log data analysis can provide valuable insights for lecturers to optimize learning design. This research opens up space to formulate implications and recommendations, including further development efforts on skills that need to be improved, strategies to increase cultural awareness, and a better understanding of variations in perceptions among students. Thus, this study provides a valuable contribution to understanding students' digital skills in blended learning environments, providing a foundation for further discussion and development actions based on research findings. Further research is needed to identify the types of digital skills students acquire through increased Internet use and how these skills align with the demands of the digital era. While various studies define digital skills, it is also necessary for future research to delve into the nuanced influence of demographic and socioeconomic factors on specific digital skills, providing a more detailed understanding of tailored interventions.

The research suggests that teacher education programs should incorporate activities that foster creativity and flexibility, such as project-based learning and problem-solving workshops, to enhance student engagement and skill development. Enhanced e-learning features, such as real-time feedback and adaptive learning modules, can also enhance learning experiences. Regular analysis of e-learning activity logs can help identify areas for improvement. Blended learning programs should capitalize on students' strong ethical and cultural competencies by incorporating cross-cultural collaboration projects. Future research should investigate digital skill trajectory, demographic and socioeconomic influences, and technology-specific skill development. Comparative analyses between traditional, fully online, and blended learning environments are essential for fostering diverse digital skills. Long-term research should investigate the career readiness of students equipped with enhanced digital skills.

ACKNOWLEDGEMENT

This study was funded by the Research Grant for Improving the Quality of Learning (PPKP) Faculty of Teacher Training and Education, University of Bengkulu 2023 (grant number 8354/UN30.7/PP/2023).

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